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The purpose of this report is to summarize current knowledge about the predictors of creative performance, to indicate some of the promising research leads, and to outline some urgent research needs. This summary, an interpretive and evaluative review, is intended to fill a portion of the need for a single, critical review of the literature on predictors of creative performance.

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PREDICTORS OF CREATIVE PERFORMANCE

A Status Report of Present Research Knowledge and Some Implications for Research

Calvin W. Taylor and John Holland

The purpose of this report is to summarize our current knowledge about the predictors of creative performance, to indicate some of the promising research leads, and to outline some urgent research needs. Currently our knowledge of predictors of creative performance is reported in a great variety of scattered sources, including unpublished materials. There is no single, integrated, critical review of this diverse literature to which the researcher, educator, or layman can turn to for a useful, succinct overview. This summary, an interpretive and evaluative review, is intended to fill a portion of this informational need. Although it is perhaps premature to make judgments about some kinds of variables, it seems, however, desirable to delineate the nature of those personal and situational attributes which are most predictive of creative performance so that others may build on such information without reworking earlier research. A review of this kind also lends itself to a clarification of the more promising kinds of predictors and a more explicit statement of our more urgent research needs. These problems are discussed in the following sections: (1) The Nature of Creative Persons--Creative Attributes and Measures, (2) Methodological Procedures and Problems, (3) Concurrent Validities of Variables Related to Creative Performance, (4) Predictive Validities of Variables Related to Creative Performance (External Criteria), and (5) Research Needs.

Parenthetically, it is elementary, but of fundamental importance to note that the use and construction of predictors assumes that we have an explicit,

relevant, external criterion of creative performance which we hope to predict with our personal and situational variables. Tests of creative ability, used as criteria of creativity (because of the appearance of validity in the nature of the processes tested), are at best, only immediate and inadequate criteria, which, if relied on extensively, may involve unnecessary risk and the likely possibility of missing our chief criterion, namely adult, creative performance.

It should be explicitly noted that the motivation of many of the workers in this area is to learn about and understand the nature of the creative person. A main goal of this search for understanding is a battery of tests which will provide more effective identification of the creative individual and thus more effective prediction of later creative performance. The next section is designed to give a tentative description of the creative individual. This description is based both on past research and on speculation about the nature of the creative person.

The Nature of Creative Persons-- Creative Attributes and Measures

Traditional Measures Inadequate.

Before presenting a detailed tentative description of the creative person, preliminary comments will be made about certain widely available measures of psychological characteristics. If school grades were efficient predictors of creativity, the identification of persons with more potential to be creative from those with less potential would be a simple one. Although certain school grades have been shown to have low validity for the prediction of creative performance, school grades in general have little or no validity for this purpose. Academic performance usually involves activities that do

not require creative performance. Such grades have low relationships or are unrelated to creative performance and to research performance in scientific laboratories. The nature of school activities may have to change so that creative performances and behaviors are demanded, if grades are ever to become useful in predicting creative performance.

Intelligence tests suffer from the same deficiency. If traditional intelligence tests were valid measures of creative potential, again the prediction problem would be a small one. But the evidence suggests that intelligence tests are not very effective measures of creative potential, for intelligence, as measured, accounts for only a minor portion of the variation in creative performance (Getzels and Jackson 1959, Torrance, 1959 -- replicated several times since by Torrance).

Likewise, it is helpful to speculate about the relationship between the sheer accumulation of knowledge and creative performance. In thinking about learned members of the academic world, it is easy to cite persons who are extremely well-versed in their field but who have demonstrated little creative behavior. One also can name persons who are productive and creative who are sometimes criticized by some of these same scholars for not being well read and for not giving due veneration to past knowledge and to the accepted orientations in their field. This basic conflict faces the oncoming generation of students as they choose to be merely learners of the known or also producers of new knowledge. Some researchers in creativity are not persuaded that the sheer accumulation of knowledge will necessarily lead to the incubation and insight stages of the creative process. In other words, sheer mastery of knowledge is not believed to be a sufficient condition for the occurrence of creative performance. A striking illustration of this hypothesis is provided by Pasteur's

experiences. After he had established a reputation as a researcher, he was recruited to work on a problem about silkworms. Shortly thereafter, one expert in silkworms interviewed Pasteur and was surprised to learn about Pasteur's ignorance of silkworms--that he was truly a novice. But after a relatively short period of time, Pasteur--not the experts-- achieved a useful solution. The many scholars who were so much more expert or knowledgeable had been unable to make the contribution that Pasteur made. It is quite possible that for making this achievement, Pasteur needed a minimum of the most relevant knowledge, but also needed certain important intellectual and motivational attributes not usually called for in the scholarly methods of mastering knowledge.

If the accumulation of knowledge were sufficient for predicting creative performance, then the problem of identifying creative potential would be near solution. We would only need to find and use the most efficient methods known for acquiring information. But there are many signs that the possession of knowledge does not guarantee that the remaining steps in the creative process will occur. A qualification about this generalization seems necessary, however. For two persons with equal potential to be creative in a given field, it is hypothesized that the one with the more knowledge that is relevant (but not redundant, misinformation, or erroneous speculations) will perform more creatively. It is advisable, then, to include in the studies of creativity, some existing tests of aptitude and relevant achievement for the field under study.

Early Stage of Research Knowledge.

Scientific knowledge about creative talent is in a very early stage, but there are many indications that some progress has already been made--we have

some useful and promising beginnings. We are at the stage where it can no longer be said that research cannot be done on creative talent. In fact, there are now too many leads to follow rather than too few leads. There have been a small number of validation studies of selected creativity tests (predictors of creativity) and a few criterion studies to determine the relationships among creativeness in various kinds of creative contributions. Many other tests have not yet undergone validation and many new ideas have been proposed for tests which have not yet been developed. Cross-validation studies have been infrequent as have been parallel studies of creativity across different fields of science and across non-scientific fields. There are some preliminary investigations about how different educational and training programs and different working environments might modify creative performance. As a consequence, corrections for education and for working environments may eventually be added to our prediction formulas. Constructive action to modify our educational programs and environmental conditions may increase the emergence of creative activity and reduce the problem of identifying the creative individual.

While there have been several studies on the attributes of creative persons, very few of these have been validation studies in the conventional sense. In fact the 1959 predictor sub-committee cited only three, by Cattell, Drevdahl, and Sprecher, that had been completed. One striking thing has occurred, however, in many studies of creative persons. A sizable number of personal traits (e. g., independence) have emerged as being relevant to creativity with surprising consistency across the majority of such studies. This consistency is in sharp contrast with the usual conflicting results often found in early stages of research in other psychological areas. This consistency has occurred even though occasionally these characteristics are of minor significance as

contributors to the total variance in creative performance.

In the following pages, nearly all of the personal characteristics found or hypothesized to date are listed. No attempt has been made to indicate the amount of empirical evidence, if any, that documents the importance of a given attribute. No attempt has been made to relate a trait to the particular type of measuring techniques or to the design of the study in which a personal trait emerged as being relevant. The reader is reminded that there may be other abilities and personal characteristics in creativity that have not yet been identified as important or that even may not yet have been discovered as psychological characteristics. As further studies are completed, it is likely that some characteristics cited now will be found to be peripheral or of no value. It will be helpful if this long list of characteristics can be reduced and given a better organization and if the appropriate traits can be related to different types of creative talent. Nonetheless, it is a hopeful sign at this time to have so many tangible and suggested characteristics that may be important in creativity.

Intellectual Characteristics.

Based upon insights derived from factorial findings of his own and of many other workers, Guilford has developed and listed the following specific factors or intellectual characteristics as most likely to be valid measures of creative talent: originality, redefinition, adaptive flexibility, spontaneous flexibility, associational fluency, expressional fluency, word fluency, ideational fluency, elaboration, and probably some evaluation factors. (While their relevance as measures of creativity is still being determined, there is little doubt that they are measuring new intellectual abilities generally ignored in talent searches and at many levels in most educational programs).

In broader terms, some components of memory, cognition, evaluation, and more particularly convergent production and especially divergent production are involved in creative work. The divergent production area is possibly the one which has been most overlooked to date in our efforts in measurement of the intellect. It appears to be a most important area of study in creative talent, since it includes the production of ideas in quantity and in quality, originality, flexibility, sensitivities, and redefinition abilities. Pictorial fluency may be an example of a characteristic needed more in creative work in art than in science.

Convergent (reduction) thinking undoubtedly also has a role in creative work. Research findings on communication abilities at Utah would suggest that the ability to converge and recognize a correct answer on a multiple choice task is probably not sufficiently similar to be used as a substitute for an open ended task of extracting a fresh generalization from a mass of data or otherwise expressing one's own product as a result of convergent thinking. While many useful things can be accomplished by using separate answer sheets and multiple choice questions, no one should conclude that we can measure everything by using them. The self selection among lots of alternatives of a route judged to be best to take, including the repudiation of other alternatives, seems to be involved in this divergent convergent sequence. Compactness of thinking and expression may be related to the elegance of the final product.

Mainly as a result of Guilford and Wilson's particular factor study on creativity, certain batteries of tests usually including mainly divergent thinking tasks are being used in some industrial and educational settings to identify creative talent. Persons selected by this type of creative battery have shown a higher degree of certain intellectual characteristics, such as more fantasies

and more ability and tendency to toy with ideas, than found in comparison groups selected solely on the basis of high IQ scores. They also tend to be more able to suggest solutions when problems arise with gadgets, than to merely "curse the gadgets," and also show stronger tendencies to be humorous.

Ability to see patterns in data and to sense problems are other intellectual characteristics that are usually included in creativity. The capacity to be puzzled may be a very important characteristic, with motivational features, too. A keen observer once said that part of Einstein's genius was his inability to understand the obvious. Thus the rejection of superficial explanations of one's own as well as of others and to know when you don't know may be crucial in making original contributions.

The ability to sense ambiguities, plus effective questioning ability, may be important in creative activity. This inquiry ability may alternately be described as curiosity in action. Many of the components of curiosity and of motivation may be of an intellectual nature.

A revision test, even though it involves only verbal revision, has been used since it is analogous to the manipulation, restructuring, and reworking of ideas found both in the earlier and later stages of the creative process. It is probably also related to the ability and tendency to strive for more comprehensive answers or solutions or products, another feature that has emerged in on-the-job studies of creativity. Intellectual thoroughness has also been valid in more than one study. Unfortunately, there are probably too few occasions in our academic programs requiring such revisions and strivings for a higher quality or for more original and workable products. Likewise, most of the other creative characteristics are often ignored or not particularly stressed in present academic programs.

A study of the products of scientists led to the finding of two quite unrelated quality ratings. One was called high level quality without originality and the second was originality type of quality. Judgments of work in school may yield separate indicators of these two different types of quality, with the originality quality expected to be a better predictor of future creative performance.

Somewhat in contrast with this previously described reworking and thoroughness characteristic, we found a verbal superficiality factor. At least in science and perhaps in certain other fields, it seems unlikely that either creative or profound contributions will come from dilettantes.

The AIR Test for Selecting Research Personnel had the most significant, though somewhat low validities against an originality criterion for the scientists studied by D. W. Taylor, as reported at the 1957 conference.

In creativity training sessions, one might build measuring devices to identify those with the greatest readiness initially for such training as well as those who show the greatest gains during the training. Similarly, a large gain in scores on creativity tests through direct practice on the test may be a valid indicator.

At least two response-set factors may measure characteristics functioning in creativity. The first one is called "broadly diffused attention." This type of attention has often been a part of the description of the crucial moments preceding the insight stage of the creative process. The second response-set factor is described as a "resistance to idea reduction." The opposite end of this trait of willingness to reduce ideas may be valuable in creating broad new generalizations. In contrast there are the persons who make second-order corrections on such generalizations; they may be resisting what

they sense as an overreduction in ideas represented by the broad initial generalization. Both types probably have some value in leading toward creative performance.

Creative persons in several fields usually state that they work intermittently across long periods of time (though perhaps almost continually below the conscious level) on their key problems. Consequently, Ghiselin has suggested that we try take-home aptitude tests to find those who continue to be involved and who jot down additional responses whenever and wherever they occur. Scientists may not need to be able to produce great quantities of ideas, but merely one, good new one to pursue as he completes each study. Similarly, the ebb and flow of ideas in the creative process suggest the need for tests which assess variability of performance within an individual across time. Presumably the creative person may often function at low level, but occasionally functions at a very high level. Maybe the person with the greatest variability across time has more creative potential.

Other tests or test ideas that may have validity include the abilities to form and test hunches (hypotheses), to foresee consequences, to infer causes, to evaluate revisions in a product, and to be able to toss one's ideas into the arena of ideas. The finding of a verbal originality factor as most characteristic of Ghiselin's interesting test in which the subject must create new compound words leads us to hope for an analogous measure of <u>nonverbal originality</u>. Another idea by Shockley is that creative thinking may require the manipulation of several ideas at a time in one's mind. We lack a test for determining the idea manipulation capacity of an individual. An interesting related question is whether such idea power can be increased by forming and training teams of workers.

The more creative scientists rate themselves high in creativity, cognition, discrimination of value, flexibility, academic achievement, and intuition. An early interest in intellectual activities plus above average breadth of interest have been found on both biographical and interest inventories for the more creative physical scientists.

Thurstone suggested that a creator has good rapport with his pre-focal thoughts. We also need measures in the areas of imageless thought, preverbal thought, preconscious thought, and in the relations between thinking and the formulations of expressions for this thought. The ability to make good intuitive decisions on the basis of incomplete information may be relevant. Barron has suggested that we need to test the ability to express the heretofore unexpressed experience or phenomenon. He feels that creatives are more open to relevant experience and more observant (seeing both what others see and what they do not see), that they place high value on accurate reporting and testifying about their observations, and that they have the ability to make them explicit. They also sense more complexities in the world, are more complex as persons, make richer syntheses, and note their own impulses more. We might add here the possible importance not only of an <u>ability</u> to sense but also of the ability to question the implicit. Our guess is that there are some important unmeasured characteristics in the ability to pioneer and blaze trails in an unexplored area. Perhaps we seek those who show positive abilities rather than strong fears when the opportunities arise to take a new step forward, to pioneer and blaze trails at the frontiers. So far there is no evidence that the sheer amount of education may not be a good basis for identifying those ready to take a new step. We may need to identify and develop people who can learn the past without taking it as a straightjacket. We may be seeking persons who can use the past as a way to future developments

and who can find new ideas and do something with those ideas to improve upon the past.

To summarize the current understanding of the intellectual aspects of creativity, there seem to be many relatively separate intellectual components. It is therefore likely that multiple types of creative talent may exist. Another general hunch is that certain of these intellectual components may underlie some of the motivational forces in the creative person and may also be linked significantly to certain personality characteristics.

Motivational-Interest Characteristics.

Many relevant characteristics have been suggested in this area. The great need is for better measuring instruments (for all ages) that will demonstrate our general belief that motivation is a strong component of creativity. In the Utah study of Air Force scientists, motivation was, however, only a small component of creative performance. Some motivational characteristics suggested are curiosity or inquiringness of mind, initiative in his area of work, enterprising in ideas, liking to think, liking to manipulate and toy with ideas, intellectual persistence, inner-directed need for recognition for achievement, need for variety, need for autonomy, need for preference for complex order and for challenges therein, esthetic and certain religious orientation, tolerance of ambiguity, resistance to closing up and crystallizing things prematurely coupled with a strong need for ultimate closure, need for mastery of a problem, insatiability for challenges of intellectual ordering of the apparently unclassifiable, and a need to improve upon currently accepted orders and systems. The use of passional sources of energy and kinesthetic cues may be important. High energy with vast work output through disciplined work habits is usually found.

Bloom has indicated that science students who truly become involved in research work and in the research role during graduate training, tend to become the productive researchers afterwards. Contrarily, those who do not get really involved in research as they finish their advanced degree requirements but somehow get by this hurdle without becoming involved, usually manage not to produce research afterwards and also usually manage to avoid research opportunities, let alone trying to cultivate them. If the creative are to be found somewhere among the productive, then in science we can reduce our problem by finding those students who truly become involved in research problems during their academic career. Some analogous situations entailing student involvement could also be sought in non-scientific fields. We might seek out such persons at almost any academic level if we would set up the situation properly and ask for the right type of performances.

According to Kuhn, a strong commitment to and a great involvement in some particular approach has usually been an important aspect in making true research progress, at least at certain stages of the scientific venture.

Other traits suggested are a willingness to take greater and more long range risks for greater gain, and the tendency to accumulate an overabundance of raw stuff for the task at hand plus a willingness ultimately to discard some of it in forming final products. One provocative idea presented at the 1955 conference by McClelland (on which all results have not since been positive) is that the creative person is willing to take a calculated risk larger than others (though not unrealistically large) and that his judgment of the odds in research areas is actually smaller than the average judgment from other persons. The creative individual presumably does not want to deal in

a sheer gamble situation but rather to engage in a risk situation where his own efforts are involved so that they may make a difference in the odds. The creative may not hold man's knowledge in awe nor tend to enshrine it, but instead, he is capable of revolting against some of the past knowledge and experiences of men.

Barron reports that the creatives have an intense esthetic and moral commitment to their work. They may also sense at least vaguely, a distinct sexual meaning to their act of creating.

Younger persons with creative talent, according to Getzel's findings, have a much greater variety of occupational choices, with greater interest in and awareness of unconventional careers, than do their fellow students. They sense that their views are not the predominant ones with reference to what success in adult life is. They are also willing to be nonconforming and consequently to be in the small minority.

The more creative scientists rate themselves high in drive, dedication to work, resourcefulness, desire for principles and desire for discovery. They have a high minimum aspiration level in quantity of written work output, theoretical contributions, being well liked, and level of original work that they hope to produce.

Group Indicators of Creativity.

In seeking the creative, one may find some important leads by looking somewhat away from instead of directly toward the target. Clues for identifying creative talent may be obtained by watching the reactions of others aroung a person. There is some support for this hunch from the work at Minnesota. If some persons in a group appear excited, disturbed or threatened, perhaps there is a creative person around whose ideas and work

are being at least vaguely sensed as threatening the present scheme of things. Some group behaviors may occur as an attempt to eliminate or reduce this threat, such as by developing sanctions against the person and by over-organizing and building other controls into their world. An experimental approach may be tried here by removing one person at a time from the group to see in which case the group tensions are reduced the most. Unfortunately, one may also locate disturbed persons in addition to some creative individuals by this procedure. The creative person in his striving for autonomy may attempt to work his way out of blocks to creativity emitted by others and out of unnecessary restrictions and organizational controls.

Tendencies to strive for more comprehensive answers together with tendencies to be intellectually thorough may lead to difficulties with some teachers and some consequent feelings of frustration and confusion in such students. Jex also reported at the 1959 conference that high school science teachers with higher creativity test scores were related below average in overall teaching performance by their principal or immediate supervisor.

The results from Torrance's descriptions from one's fellow students seem promising. Similarly, Harmon's findings in the 1957 conference report show positive results for recommendations obtained on confidential report forms. Consequently, well designed confidential reports including ratings, check lists, and written descriptions from peers and from appropriately selected teachers and supervisors (as well as ratings on oneself) should not be overlooked as possibilities for identifying those with above average promise of being creative. One basic question here is to what degree a rater must have creative characteristics himself in order to be able to judge whether another individual has a high degree of these characteristics. Another problem is how to get ratings and recommendations that somehow have had, at least partially

controlled out, any potential negative reactions to the more creative individual.

In group discussion sessions (including brainstorming sessions), individuals differ widely in their contributions to the flow of ideas. Some persons help to set the stage while others make crucial leaps ahead in the discussion. Some persons do not slavishly follow the flow of the discussion. Instead, they think "at right angles" on an unusual train of thought. Later they may speak up to send the discussion down new and fresh avenues. For example, one person did this several times recently during a tape-recorded session, whereas the contribution of others seemed to be merely minor variations or refinements around already existing themes.

Some persons may serve as good catalysts to stimulate ideas and creative thinking in others. Other persons may be skilled in utilizing others effectively to stir their own thinking along new lines.

Some unexpected but intriguing and meaningful results were found in a criterion study pertaining to working conditions for researchers in one scientific laboratory. The number of published scientific articles was negatively related to rating by supervisors on cooperation and flexibility. In other words, those who go the "extra mile" and publish their completed research may pay a price in some situations of being judged uncooperative and inflexible by their supervisor. The second finding is the one which is more directly concerned with creativity than with productivity. Those who had the fastest promotion rate had been credited with very few official suggestions and rated themselves below the average rating in their desire for discovery. For this one situation, those who had a strong desire for discovery and who made good official suggestions to the organization, had a below average rate of promotion.

Other Personality Characteristics.

Some evidence to date on personality characteristics suggests that creative

persons are more devoted to autonomy, more self sufficient, more independent in judgment (contrary to group agreement, if needed, to be an accurate judge), more open to the irrational in themselves, more stable, and more capable of taking greater risks in the hope for greater gains, more feminine in interests and characteristics (especially in awareness of one's impulses), more dominant and self assertive, more complex as a person, more self accepting, more resourceful and adventurous, more radical (Bohemian), more controlling of their own behavior by self concept, and possibly more emotionally sensitive, and more introverted but bold. Cattell warns that exuberance, which decreases with maturity, should not be confused as being synonymous with creativity.

Creative scientists rate themselves high in professional self-confidence, self-sufficiency, independence, emotional restraint and they rate themselves low in aggressiveness, assertion, social desirability, sociability and masculine vigor. They tend not to give a modal response on multiple choice biographical questions.

Other personal characteristics which may differ in relevance across different fields are: liking for ideas vs. people vs. things, socialization and interpersonal involvement tendencies, introversion-extroversion, surgency-desurgency, commitment to primary vs. secondary thought processes, and impulse control (suppression vs. expression). In many fields there is often an incubation period, though differences may occur in the insight period.

Nearly every time that even a brief biographical inventory has been tried on scientists. it has been found to have promising validity in the initial sample studied. Indirectly these items are getting at a hodgepodge of motivational and personality traits such as work habits, attitudes, interests,

values, family and academic history, and several personality characteristics.

Some differences in personality characteristics may occur across fields. For example, one view is that whenever some persons have an inspiration in certain fields like art, they have to get to their canvas quickly before their feeling vanishes. The special role of space and visual imagery in art and of time and auditory imagery in music needs investigation. The special importance of mastery of techniques of expression in each creative area have also been stressed by some creative persons. The different styles of creating within science have been studied with some success by Gough (1958), suggesting similar possibilities in other areas of creative endeavor. Individual differences in the range of creative performance is an interesting problem that has not particularly been studied. Another potentially valuable suggestion is that the creative individual has a disposition to produce adaptive responses which are original in nature. A more extreme suggestion about adjustment is that while the typical person focuses on adjusting to his environment, at least some creative individuals are trying to adjust the environment to improve it in ways that they sense and feel are urgently needed.

A recent hunch by Reverend Maurice McDowell which appears to be a restatement of certain of the previous ideas is that Einstein was motivated by being hostile toward the tyranny of the unknown. Since he has been reported as not seeing the obvious, or that which others see as obvious, one may infer that he may have had some hostility toward the tyranny of the acceptance of the obvious by others--the potential tyranny of accepting as known that which is really filled with some unknowns.

As stated earlier, the "dead-wood" characteristics of creative potential

need to be identified and cut out from the broad set of variables reviewed here. The validity of each of the remaining characteristics as well as the validity of a best weighted combination of these characteristics is needed for each field and kind of creativity.

Methodological Procedures and Problems

Sources of Information.

Several different sources may provide information that will be useful for identifying persons with creative potential. Generally, the person himself has been the main source of information--he is either asked to perform on certain tests or tasks or he is asked to fill out forms on which he describes and rates himself in various ways. Other sources of information might include his parents or family members, his fellow students or work associates, his teacher or supervisor, or other relevant persons who would give information in the form of ratings, checklists, descriptions, etc. These sources have not been used as frequently in creativity studies as their value in other studies indicates. Official records and tangible products and accomplishments provide possible scores for identifying creative potential. Predictor scores from tangible products and accomplishments have shown some promise in the few times used.

Types of Measures Used.

The typical emphasis in investigations of creative promise has been on a broad range of assessment variables, somewhat in contrast to the identification of the so-called intelligence type of giftedness by means of a single measuring device such as an I. Q. score. Creativity measures have included

intellectual (mainly new intellectual characteristics not included in I. Q. tests), motivational, biographical, sociometric, and other personality characteristics in attempts to understand the nature of creative talent and its identification. In fact, some researchers have been attempting to measure creative talent from any angle and by any set of characteristics possible. (However, to our knowledge no attempts have been made to do pattern scoring across items or profile scoring across tests in studies of creativity).

Designs of Validation Studies.

As preliminary to a main study, the approach used by Hill and also by Guilford and Allen has merit. They described a list of measurable psychological characteristics and let the specialists in the field judge which of these characteristics are more important for creative work in their field.

Many different designs have been used and are described here. Most of the studies have been planned in order to find the more creative persons within a group rather than to discriminate groups of people in more creative work from groups in less creative work. Some studies have entailed descriptions by creative persons of their own creative processes and experiences. For example, Ghiselin (1955) reported on how this approach of obtaining descriptions of the creative process might eventually be of help in the problem of identifying the creative individual. More recently he developed a Creative Process Check List with the hope that it can be scored in a way that will separate more creative from less creative persons. Cattell (1959) reported a biographical study of eminent persons in the history of science, as an interesting exploratory approach to discover characteristics of creative scientists.

A second kind of study requires groups of carefully selected creative

persons (in whom creativity is presumably present to a higher degree or in a more pure form) who are then studied intensively to obtain a set of characteristics common to the group. The need for appropriate comparison or control groups has sometimes been ignored so that this kind of study is unusually ambiguous. In some instances, the norms for the creative group may be compared with the norms for the population in general whenever the tests used already have such standards. Generally, the use of new devices or scales precludes, however, this advantage. Rarely have investigators used a well matched control group of uncreative persons consisting of persons who at one stage of their career were equal in promise in certain characteristics to the creative group but who had failed to perform creatively.

Another common fault is that in many studies a great effort is put into the development and selection of psychological devices but very little effort is devoted to the criterion problem(frequently studies use only available data as criteria of creativity). In other studies, perhaps one or more criteria become available (such as completion of a doctorate -- admittedly not necessarily a criterion with much creativity in it) which leads one, so to speak, to look into existing files for predictor data to validate against such criteria. In two or three isolated cases, intensive work has been done on the criterion part of the investigation. Our conviction is that there are no more crucial problems underlying the total area of creativity than the criterion problem.

Many studies have yielded concurrent validities of various predictors. A type of study used early in the high level aptitude area which opened the way for much effort in research on creativity was the factor analysis of large, well-designed batteries of appropriate tests.

Still another kind of concurrent validity study involves the use of a single test score or a battery score derived from selected creativity tests as a test criterion and then the correlates of this criterion are discovered. This type of study includes those investigations in which a highly "creative" group are identified by means of a "creativity" battery score and then studied for other characteristics and compared with another group selected on the basis of another type of test score. Studies of this type have certainly had an important effect of arousing interest in creativity. (This general type of study has been repeated almost endlessly during the last three decades in studies of high I. Q. groups.)

Another kind of concurrent validity study has included both tests and one or more external criteria of performance, usually work performance. Such studies provide individual validity coefficients. Multiple correlations and factor analyses studies, including both tests and criteria, have been or can also be accomplished in these same projects. A minor modification of this plan is to determine group differences on suitable external criteria for two groups formed on the basis of selected test scores.

In general, some creativity studies in each of the designs reviewed here have been completed. All of these study plans have special limitations.

The results of concurrent validity studies -- where external criteria and test data are collected almost simultaneously -- need to be verified in predictive (longitudinal) validity studies using external criteria. Such predictive studies are infrequent and are sorely needed on the most promising predictors available.

Size and Nature of the Samples Studied.

Perhaps too many studies have dealt with relatively small samples.

Replications on larger samples are needed to secure more reliable results, although some findings have occurred consistently across several small studies.

The nature of the specialty of the groups studied has varied, but not in any systematic way, with physical science and engineering fields being emphasized more than other fields like the biological-medical sciences, the social sciences, the arts, the humanities, accounting, etc. There is a need to learn to what degree the same findings occur in these other fields or whether different personal characteristics are involved with a change in subject matter and with a change in channel and form of expression. Another related question is whether there are several different types of creativity within a given field, and whether one or more of these types is found in other fields of specialization, and in other activities such as in administrative work or in other forms of leadership. Already a few completed comparative studies and several in process which are concerned with the differences between the physical sciences and one of the arts appear promising and may yield helpful ideas for understanding the nature of creativity in the sciences.

Any effects of other potentially relevant variables, such as age, amount and types of education and experience have not always been studied or controlled in recent investigations. A major complicating feature of most studies, which makes the interpretation of the results especially ambiguous, is the restriction-of-range problem. Such restriction of range or homogeneity of the sample is most worrisome when the variables on which the restriction has occurred are related to the variables focused upon in the study. However, if the sample is homogeneous on variables unrelated to the variables investigated, no restriction of range effects would be expected in the pertinent variables under investigation. Furthermore, if zero correlations are found in many validity coefficients in a homogeneous sample, it is expected that many of these validity coefficients would remain essentially zero in a more heterogeneous sample.

Consequently, investigations are needed to clarify what the restriction-of-range effects or absence of effects have been in the completed studies on creativity.

Another problem occurs in the study of different age groups. Since most studies have been done on adults, many assessment devices must be revised so that they can be administered to adolescents or to young children. In other instances, entirely new measures that presumably measure creative characteristics have been developed for children. In both instances, there is a need to know whether the same characteristics are being measured in children and in adults and whether these variables are more valid measures in adults or in children. In very recent unpublished work Guilford has found that the divergent thinking portion of his "Structure of Intellect" has been found to be essentially the same on 6th graders and on 9th graders as on adults, although a few specific tests must be watched carefully because they change in nature across these differing age groups.

At least one study (a dissertation in process by Eisner at Chicago) is deliberately designed to study four different hypothetical types of creativity within one field.

Concurrent Validities of Creative Performance

Correlates of Tests of Creativity--No External Criteria.

Many factorial studies completed in this area have had a pioneering effect. Even though external criteria have been omitted, the analyses of correlations among various types of measures of fluencies, flexibilities, sensitivities, originality, and personality characteristics have yielded some

consistent findings across studies on adults. The division of the problem of creativity into various components (or factors) has provided tests with known factorial content and a technical vocabulary of descriptions, especially in the divergent type of thinking, that has undoubtedly stirred thinking and research in creativity in many ways. These studies have been best summarized by Guilford (1959) and by French (who held a second factor analysis conference in 1959 to expand the ETS factor analysis kit of tests).

Except for studies currently in process, external criteria of creativity have usually not been included along with the set of tests in factorial studies of creativity.

In another kind of study, many investigators have used one or more of a variety of psychological tests (including self ratings) as criteria of creative performance. Such devices have included: A battery of tests from the Guilford Creativity Battery, single tests of the same type such as free responses to problem questions (What would happen if?), unusual uses of common objects, and special scorings of the TAT and Rorschach for creative responses. Studies by Barron, Getzels and Jackson, Torrance and others illustrate the use of this method for learning about groups of people characterized as high scorers (more creative) and low scorers (less creative) on such devices. The use of such scores as criteria has led to the development of some promising predictors. As a first step, this plan for investigating creativity appears then to be a useful one: it provides usually a reliable, immediate criterion. The value in such a criterion for discovering and validating predictors lies in the degree to which such devices are equivalent to other more remote or relevant criteria of creative performance. Questions of criterion bias and

contamination are probably very relevant on this issue. Unless such criteria (scores in creative measures) predict real creative performance, they will provide erroneous information about the nature of creative persons and creativity. Such "validation" studies perhaps should be regarded as useful steps in exploring the nature of creative performances. On the positive side, test scores as criteria of creativity may be useful in isolating more explicitly the nature of adult creativity performance when they are also later employed as predictors of creative performance in follow-up (longitudinal) studies.

External Criteria as Bases of Concurrent Validities.

The following sub-sections summarize our knowledge of the concurrent validities against external criteria according to the general type of measuring device.

1. High Level Aptitudes. Special aptitude tests devised to construct creative ability such as the Guilford battery have had only modest success. The evidence for the validity of such tests is still incomplete and unclear. Some evidences of restriction of range are present and make results unclear in a few studies when these types of tests do not provide significant validities. Chorness and Nottelman (1957) found that an intelligence measure predicts employee "creativity" as well as selected tests from the Guilford battery. In such instances, it should be recognized that within the academic world as well as in the initial placement into the world of work those with high intelligence scores probably have an initial advantage and headstart due to current emphases, whereas those with high scores on more creative-like intellectual characteristics probably must use on their own without such an initial advantage.

The majority of studies suggest that the relation of intelligence tests or components of intelligence tests to creative performance is generally low (.20 to .40) in unselected populations and is .00 and even negative for homogeneous samples at high levels of intelligence (MacKinnon, 1959; Holland, 1961a; Mullins, 1959; Taylor et al, 1961; and Yamamoto, 1961).

The Remote Associates Test calling for three-way associations appears to be a device of special promise. Mednick has reported in the Creativity Research Exchange correlations as high as .70 between Remote Associates scores and ratings of creative writing ability for a small sample. At the 1955 conference, the Word Association Test, scored for remote associations, appeared to be one of the most promising predictors. Since then, however, conflicting results have been obtained for this test with some zero validities and some instances where a common associations score predicted better than did a more remote associations score. Two-way association tests have been included in factor studies and usually have been found to have a similar factor pattern to the Word Association Test. How a three-way association test differs in a significant way psychologically from these one-way and two-way association tests remains to be determined.

2. Motivation and Interest Inventories. Typical interest inventories have generally been poor predictors with only a few exceptions. In a battery of 69 predictors including aptitude, personality and originality scales, self and teacher ratings, etc., Holland found simple interest measures to be among the best predictors of creative performance. A complex motivational device in study of Air Force scientists had very few significant validities against several criteria whereas a considerably higher per cent of the validities

were significant for a brief and simple device measuring minimum aspirational level in several different aspects of scientific work.

3. Biographical Information. Simple check lists of background, preferred activities, expressed goals, levels and kind of desired attainment have produced predictors of unusual validity even in cross validation (.30 to .55) (Taylor, et. al., 1961; Holland, 1961b; Smith, et. al., 1961).

4. Personality and Originality Scales. The validity of personality inventories such as the CPI, 16 PF, Saunders experimental inventory are generally low, although there is considerable variation among studies by Gough,[1] Holland (1961b), and Taylor et. al. (1961). The evidence for the validity of non-intellectual originality scales falls about at the same level, although there is again a wide range of correlations. Barron, for example, reported a correlation of .70 between his Independence of Judgment Scale and teacher ratings of creativity. More typical correlations for scales of these kinds range from .10 to .30.

5. Self-Ratings. Simple self ratings in adolescent and adult samples have proved to have moderate validity for a variety of creative performances. Terman's earlier work also showed that ratings of self-confidence, persistence, and integration toward goals were among his most efficient predictors of adult achievement. In a study of Air Force scientists, a best all-round predictor of all 17 criteria was a self-rating of creativity, which also was valid for every one of the six creative criteria (criterion factors) in this study. Self-ratings on several non-intellectual characteristics also had moderate

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[1] Personal communication.

validity for many of the creative criteria (C. W.. Taylor et al, 1961). In the 1955 Utah conference, Bloom foresaw that non-intellectual scores account for at least as much as intellectual scores in creative criteria. In the new Utah study of high school students in NSF Summer Science Institutes, we should learn whether students of this age who have had no job experience in science can make self-ratings that are as valid as those obtained from more mature and experienced scientists.

6. Ratings by Others. Teacher ratings appear to be of little value for predicting creative performance although they are useful for predicting other kinds of performance.. Supervisory ratings, however, appear to be of some value (Buel, 1960). Supervisory ratings of creativity have been used with success as rating criteria, with psychological scores correlating significantly with such ratings in several studies, such as the study of Air Force scientists mentioned above and the current Utah biographical study of NASA scientists. Peer nominations and rankings also worked well in the study of Air Force scientists. Well constructed ratings and descriptions from appropriately selected recommenders may be one of the more promising approaches for predicting creative performance.

7. Special Devices and Tests. Several investigators have begun work on unique devices and techniques. Currently, no evidence for the validity of these techniques is available. A new individual device called Problem Solving Apparatus invented by John and Rimaldi (1957) and used by Stein is highly complex and interesting and may have potential as a predictor. New tests developed by Art Educators may have merit. One built by Art Educators in Florida consisted of parallel rubber strands strung across a peg board so that by the insertion of pegs and interlacing of the strands, many new designs or continually changing series of designs were possible. Another unusual performance test with promising

reliability over time is the one in which examinees are given art materials and told to draw a "mess."

8. Physical Measures and Effects of Drugs. Certain drugs have been used which, through biochemical and physiological changes in the body, yield interesting reactions and experiences that have been studied in connection with creativity. To what degree these drugs or measures of physical and physiological characteristics can contribute to identifying the creative as yet remains to be determined.

9. Situational Influences. Attitudes reported by mothers (PARI) have been found to be related to the creative performance of adolescents at a very low but significant level of correlation (Holland, 1961a). Similarly, values and goals reported by fathers are related to creative performance of his child - again at a very low level of correlation. The biographical inventory, usually completed by self-report (but which could partly be completed by parents) has also found environmental factors to have some validity.

The effects of institutional practices and atmospheres has been investigated by Knapp, 1952; Holland, 1957; Thistlethwaite, 1959; in studies which have assigned various degrees of student achievement (the Ph.D.) either to the college or to the student. Recent studies (Astin, 1961; Astin and Holland, 1961) appear to negate institutional influences on Ph.D. seeking. The number of undergraduates seeking the Ph.D. has a multiple correlation of .92 with the percentage of students majoring in science and the average academic aptitude level of the entering class for a group of 36 colleges.

Predictive Validities of Creative Performance with External Criteria

In this section, we are concerned only with those predictors which have been used in a longitudinal study (either of short range or of long range like Terman's)

to predict socially relevant criteria of creative performance. This kind of validation is most valuable since it makes empirically clear that a test or other psychological measure is or is not useful as a predictor of future performance so that its value for practical use in the selection of creative persons can be determined. Studies of this kind are so rare that predictors so studied have not been categorized in terms of their psychological attributes. While validation and cross-validation studies of the concurrent validity type are valuable, their results should definitely be replicated in a follow-up validity type of study. Crucial questions are whether the measuring instruments need to be revised for use at earlier ages and prior to certain experiences; whether the tests will arrange people in the same relative order at earlier ages, and at earlier stages of experience and achievement as they do at the stage when concurrent validities were determined. Norms may also shift in predictive studies in unexpected ways.

In a recent study (unpublished), Holland found that science achievements (winning contests, paper publication) in high school were significantly correlated with similar achievements in college over 1, 2, 3, and 4 year periods, although these correlations were of a low order (.20 to .38). However, this class of predictors (past achievement) was generally superior to other classes of predictors (aptitude, grades, originality measures). Similarly, Artistic Achievement in college was predicted best by a record (check list) of achievements in high school.

Other predictive tests of creative performance have included Harmon's two fellowship follow-up studies, one reported at the 1957 conference and a more recent unpublished one, plus Bloom's brief exploratory study reported at the 955 conference involving productivity (not directly creativity) of persons

after completing their doctorates in relation to behaviors they displayed during their graduate years. Flanagan's current Talent project is a large predictive study, although to our knowledge we are not aware of any focused attempt to obtain later criteria of creativity, though this may be included in their plans, and the Ingenuity Test which may be claimed to be the most promising predictor of creativity in the battery unfortunately has a large component of the Verbal Knowledge factor in it so that the remaining true variance, presumably measuring ingenuity, may not have too much chance to display its potential validity for predicting creative performance.

In a recently published concurrent validity study on biographical measures of creativity (Albright et al.), there appeared a brief mention of a predictive study. The current Utah biographical study of nearly 1,000 NASA scientists has yielded concurrent validities and cross-validites even in different laboratories in different parts of the country, with remarkably good results against on-the-job ratings of creativity. Follow-up studies on new NASA employees are planned in the near future as a more crucial check of these concurrent validities. The new Utah project, with NSF support, on science students in NSF Summer Science Programs is a short range predictive study across 2 - 3 months to see to what degree creative characteristics found to be important in mature scientists on the job are both measurable and valid in predicting performance in these summer programs, especially the more creative full-time research participation programs (in contrast with the full-time, school-like classroom programs). Longer range longitudinal studies on the tested students may be possible by using the samples in the nine programs being studied.

Research Needs

The Choice of Predictors.

This review of the current status of predictors of creative performance is instructive since the differences in efficiency among the various classes or kinds of predictors suggest that some predictors are generally more successful than others. When we look at predictors by class rather than by specific scales or inventories, we get a crude ordering: The biographical items, past achievements, are our most efficient predictors. Self-ratings, direct expressions of goals and aspirations are next in their ability to predict various criteria. Originality and personality inventories run a very poor third. And aptitude and intelligence measures are next (except where restriction-of-range corrections are really applicable), followed finally by parental attitudes. Although any such ordering of promising predictors is hazardous since it is subject to some unknown biases and errors, the consistency of these findings may be profitable to interpret for whatever value they may have for future research and practice.

For example, Harmon's NRC mimeographed technical reports indicate that aptitude and achievement tests as well as college grades are useful predictors of scientific accomplishment. Whether Harmon's more positive results for these kinds of predictors is due to different criteria, or whether self-ratings, past achievements and biographical scales would be better predictors for his samples is not known. Another puzzling result (which may be partly explained by restriction of range) is why high level aptitudes have shown remarkably good results against situational test criteria (as in the results of the Utah studies on communication abilities by Taylor et al. 1958) whereas they failed to show much promise against more usual criteria on the job, such as ratings of scientists

and of scientists' products.

As another example, the usefulness of self-ratings suggests that greater effort might be devoted to lengthening the measuring devices and otherwise obtaining more extensive and comprehensive self-ratings, for example, on all creative characteristics ever suggested as relevant for creativity and developing techniques for more sophisticated scoring. The effects of experience on such self-ratings is not yet known nor are we yet at all sure how well self-ratings will work at earlier and earlier ages. Some insights about this problem may emerge from the new Utah study of high school students in NSF Summer Science Institutes wherein self-ratings will be obtained at the beginning and at the end of these summer programs. Some attempts to conceptualize the development and meaning of self-conceptions may be helpful in integrating this information with the remainder of our knowledge. If, for instance, we had a workable theory of self-conceptions, we would have a powerful tool for exploring the meaning of self-conceptions and hopefully, a way of improving our predictions. As it is, the positive results for self-ratings and biographical self-reports are isolated information in our psychological knowledge.

In a similar fashion, the success of biographical blanks, scales, and activities suggest both the need to mine this area of interest and to spell out and conceptualize the meaning of this promising evidence. The designation, biographical blank, conveys ambiguous and inaccurate meanings since such blanks or inventories frequently contain a great variety of psychological information including self-ratings, goals, aspirations, attitudes about parents, vocations, hobbies and activities, past achievements, etc. Such information suggests hypotheses like the following: Past achievement predicts future achievement. The time committed to job-related activities at home is related to work achievement.

People who are original, know it -- ask them. Activities and hobbies can be regarded as long-term cathections which may call for some of the same traits and personal dispositions which creative work require. What is needed for further work are more comprehensive theoretical forms to systematize this information. Presumably such statements would serve both to order this knowledge and point to promising but neglected areas of concern.

Situational tests, per se or as part of an educational program designed to elicit creative behaviors, may prove to be very promising predictors of future creative performance. For example, some term papers could be requested which do not require the usual scholarly skills and treatment but which ask for new ideas, that are the students' own ideas, to be expressed as he would most prefer to present them. Or students could be given credit for getting new ideas of their own while they were reading or listening during usual school activities.

Work needs to be done to determine the "best" combination of all of the valid set of predictors of creativity. The present indications are that there is a long list of predictors with significant validity, including intellectual and non-intellectual characteristics plus knowledge of techniques and content (excluding external opportunity variables), but how well they can be combined to supplement each other has not been studied, either theoretically or empirically. Whether a particular "best" combination of a long set of predictors would yield sizable cross validation results or whether great shrinkage of battery validity would occur is still unknown, especially in terms of results in a longitudinal study. Such urgently needed studies are now within reach, with concurrent validities of certain combinations being readily possible

on available data.

Selection research on several national fellowship programs, including the NSF Predoctoral Program, have great promise especially if research on creative characteristics is an important part of the research program. The need for and value of sustained research effort in each of several organizations and universities has been clearly demonstrated in the difficult creativity area of research. Yet a single study rather than sustained research by an investigator has been almost the rule rather than the exception in this field.

Another problem of great national and scientific importance pertains to the evaluation of research proposals or counterpart decisions within research laboratories as to which persons and which problems will obtain the most budgetary support). It is quite possible that the most creative proposals and the most creative individuals have less chance of being supported financially than more orthodox proposals directed by more orthodox researchers in midstream of most current and thus currently acceptable research, which merely inch along but rest primarily on safe, comfortable ground. (A somewhat parallel problem in the assessment of criterion data is the question of bias in the selection of articles for publication. It has been said that the real good and the real poor articles have the best chance of being rejected whereas the run of the mill articles have a better chance). It is apparent, too, that creativity research could undergird and may make major contributions to and changes in the administration of scholarship, fellowship, research support, and research publication programs.

There is a need to improve the devices currently used as potential predictors of creativity. Since many of the aptitude tests as well as the self-ratings have been relatively short in nature, the more promising ones should be lengthened and expanded in coverage in whatever directions are possible and desirable. An expanded number of items has been generated without too

much difficulty in the area of biographical inventories and it is suspected that the same thing could readily occur in various other self-reports, self-ratings, and ratings by others. Correction scores to suppress exaggeration tendencies on biographical inventories have started to show real promise so that similar correction scores might be attempted for other self-report devices. Pattern scores across sets of two or three items may add some valid measurement not yet covered. Certainly the entire area of combination of creative scores has not been dealt with to any great extent even though a large set of predictors that now appear to have some validity are available.

New measuring devices are also needed to use original ideas for which measurements have not yet been devised. Many of these new ideas as well as initial sketches of potential measuring devices have come from creative people outside of psychology. Consequently, a plea is made for more help from persons from these other fields. For example, Shockley has suggested that the more creative person can manipulate more ideas in his mind at one time and thus has more "idea manipulation power." Ghiselin has developed a creative process check list for which a suitable scoring system has not yet been developed. Art educators have suggested new testing devices, including a fascinating, highly flexible, design pegboard build by Florida art educators for which different instructions and scoring systems could be devised to yield a set of interesting scores that might be related to creativity. Others have suggested the need for good tests of imagery, including auditory imagery in music.

Other new types of measures have been suggested by findings in other areas. For example, peer nominations have not been particularly exploited as potential predictors though they have often added valid variances in other

areas of investigation. Tentative descriptions of creative people suggest other potential new measures needed. An example is that creative people are often described as having a broader spread of intellectual interests which leads to the suggestion that the amount of information, especially the spread of the information that a person has gleaned, might be used as a measure of his breadth of interest and as a measure of his mental set and attitude toward knowledge across a variety of fields.

Theories of Creative Performance.

Currently, theories of creative performance are limited largely to simple sets of hypotheses which are concerned often with a few variables of a single kind, all aptitude, all personality variables. For example, Asher at San Jose State in an unpublished paper proposes a stroboscopic model of the creative process based upon concept constancy (flexibility of closure or adaptive flexibility). More comprehensive, hueristic theories may be of considerable use for organizing present knowledge and suggesting new research. Sprecher has recently written a preliminary hueristic theory on the creativity problem, involving goals and learning activities. At present, there are no broad sweeping, comprehensive statements, reports, or summaries of theories, hypotheses or ideas about the nature of creative behavior.

Problems of Method.

It seems desirable to perform comprehensive assessments rather than to use single or limited sets of variables, for it is only in more complete assessments that we can learn the relative efficiency of various predictors. At this time it appears that a composite of measures is necessary to obtain efficient predictions. The stability of the validity coefficients from these best weighted composites is currently a crucial problem. One of the more pressing needs (though longer range longitudinal studies must be used to

supplement and double-check such studies) is to do several relatively immediate studies of scientists on the job by using a large battery of the most promising predictors and by using several large samples of scientists in different organizational settings. As a first step we might determine the predictors which will consistently identify the more creative scientists, regardless of the organizational setting. As a second step, we might determine how well the combined set of valid predictors will correlate with the criteria of creativity, especially in cross-validation studies.

The Utah studies of Air Force scientists suggest that on the initial sample studied approximately half of the variance in any seventeen criteria of creative and other scientific contributions may be overlapped by a combination of 15 or more valid test predictors, although the shrinkage on cross-validation is as yet unknown. This phenomenon may parallel on cross-validation that which has been found for "a large battery of biographical items" wherein the initial concurrent validities for empirically constructed keys have been typically in the .70's and .80's and the cross validities have held up in the .40's and .50's on different samples of NSF scientists at different geographical locations, even with a somewhat different creative criterion in the cross-validation study. Such approaches may remind one of actuarial approaches in the insurance fields and may lead toward prediction of a fairly high degree of efficiency. The final check, however, of such concurrent validity studies will be predictive studies.

Studies paralleling the approaches reviewed here are also needed in other fields, such as the arts, social sciences, leadership, etc.

It is imperative that greater attention be given to isolating those personal attributes related to creative, scientific performance from those related to vocational status (scientist versus creative scientists, creative

biologist from biologist). Many early studies of "creative" scientists are in fact merely studies of scientists.

Creativity or creative performance within fields should be studied so that those with the most potential for each type of creativity can be identified. Comparative studies of creativity are probably more urgently needed across fields, both within the sciences and outside. It is likely that studies of creativity in the arts may provide invaluable leads for studies within science.

In addition, a knowledge of the distinguishing characteristics between fields would be valuable for counseling and differential prediction and might help those with the most potential creativity to find their best outlet or outlets. One of the greatest potential strengths of our nation lies in the possibility of having creativity occur more frequently in <u>all areas</u> of our culture.

Creative thinking is also an acute need in many fields besides arts and sciences, such as administration and leadership, political science and international diplomacy, accounting, health research and practices, old age problems, reduction of juvenile delinquency and crime, etc. In principle, creative performance must occur in all areas of human endeavor.

There is a need to explore and develop multiple criteria of creative performance at more age levels. It is clear from the large criterion study of Taylor et. al, (1959) that no single criterion of performance is adequate or desirable, since some criteria are relatively independent of one another.

There is a need to study, within longitudinal studies, both change in predictor variables and those situations which are conducive to such change.

Finally, we need studies employing large samples in order to secure more stable results and to avoid some of the restriction in range of talent as well

as the restrictions in all other personal and background variables.

The Need for Predictive Studies.

Even though research on creative process and performance has burgeoned in recent years, there are less than five predictive (longitudinal) studies with relevant external criteria. Unfortunately, the number of predictive studies is extremely limited, although it is only in this way that we will acquire valid information for learning who as an adolescent will become a creative scientist. Concurrent validity studies of tests plus the use of test scores as criteria are useful intermediate steps to obtain a wide array of potential predictors, but comparisons of concurrent versus predictive validation of the same predictors suggest that a substantial number of predictors which look promising under concurrent validity studies, do in fact, fail when the validity is checked in a predictive study.

The use of test scores as criteria of creativity is fraught with similar difficulty. Tests developed to measure creativity generally lack social relevance. Even if we can predict such measures from other measures, we are still faced with the problem -- do scores on such creativity measures have any real life significance.

Consequently, we stress in our final recommendation the great need for predictive studies in creativity research, utilizing a very wide variety of potential predictors.